

# Multi-Mission Earth Entry Vehicle (MMEEV)

## In-Space Propulsion Technology Project

The Multi-Mission Earth Entry Vehicle (MMEEV) is a flexible design concept which can be optimized or tailored by any sample return mission, including lunar, asteroid, comet, and planetary (e.g. Mars), to meet that mission's specific requirements. Based on the Mars Sample Return (MSR) EEV design, which due to planetary protection requirements, is designed to be the most reliable space vehicle ever flown, the MMEEV concept provides a logical foundation by which any sample return mission can build upon in optimizing an EEV design which meets their specific needs. By leveraging common design elements, this approach could significantly reduce the risk and associated cost in development across all sample return missions, while also providing significant feed-forward risk reduction in the form of technology development, testing, and even flight experience, for an eventual MSR implementation.

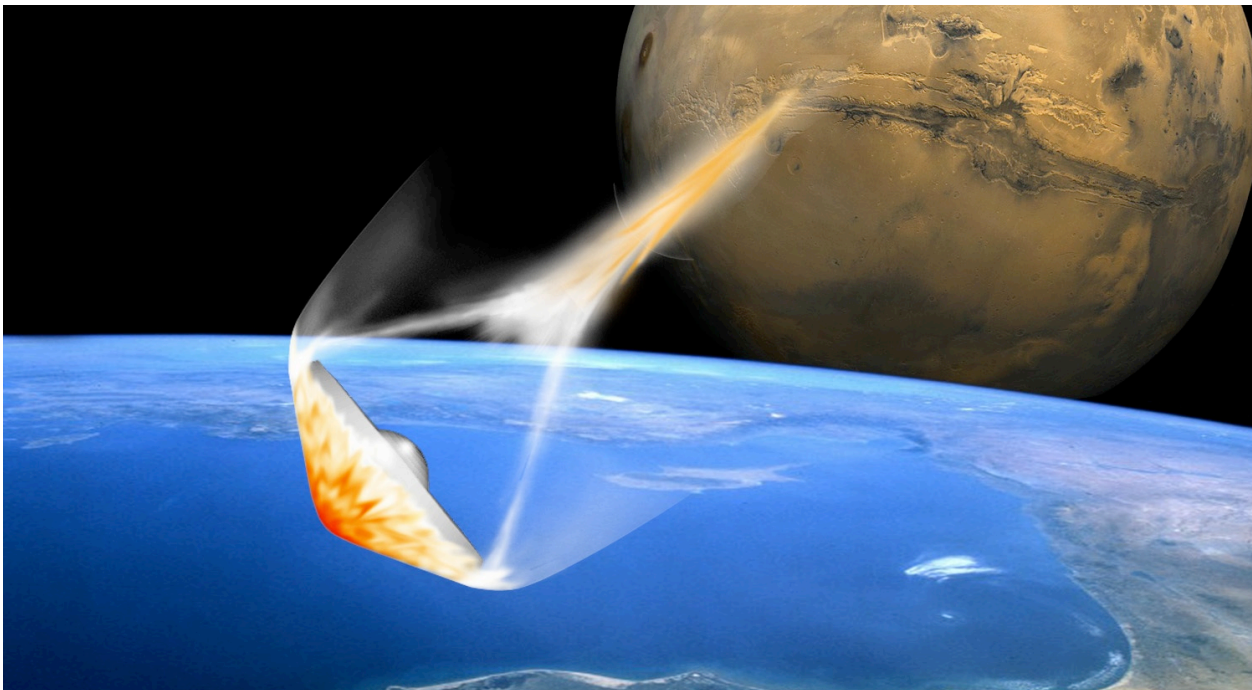
The current MMEEV parametric configuration and mass model is developed for a range of vehicle parameters, including vehicle diameter and

payload mass/size. Since each individual sample return mission may have a unique set of performance metrics of highest interest, the goal is to provide a qualitative performance comparison across the specified trade space. From this, each sample return mission can select the most desirable design point from which to begin a more optimized design.

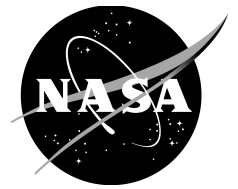
### What it takes to return samples to Earth

Detailed studies for a Mars sample return mission show that to meet the stringent containment requirements the MMEEV should possess particular design attributes. First, the vehicle aerodynamics must be very well understood. This means utilizing a shape with extensive analysis, testing, and flight experience. The vehicle aerodynamics must also be "self-righting," so it will quickly stabilize itself in a heatshield-forward orientation if the release from the return vehicle, a micrometeoroid impact, or some other anomaly, causes it to enter the atmosphere in any other

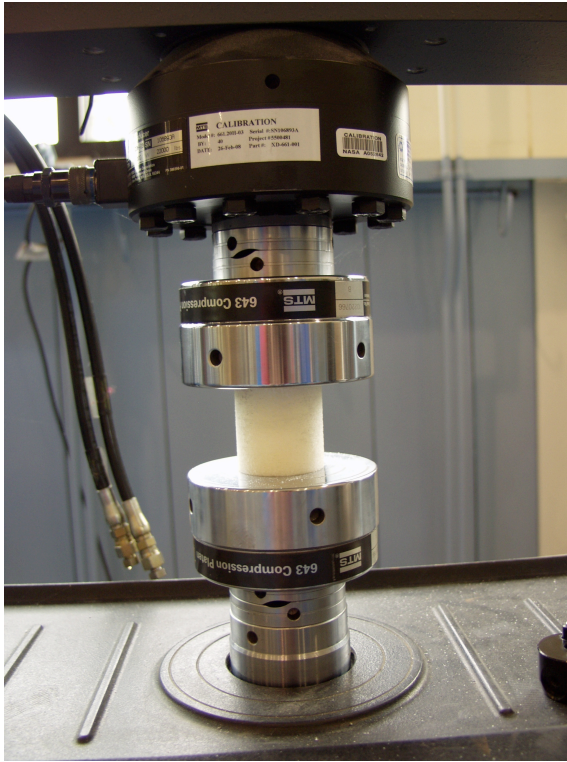
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Artist's rendition of a sample return mission.



orientation. Second, the heat shield thermal protection system (TPS) needs to be robust enough to ensure a high level of reliability for both nominal and off-nominal environments. Third, the MMEEV has no parachute or other deployable drag device, since the reliability of such a device is several orders of magnitude less than the level that will likely be required (i.e. the capsule would still need to be designed to survive and safely contain the sample after an Earth impact in the event of a parachute failure).



Testing of impact foam sample

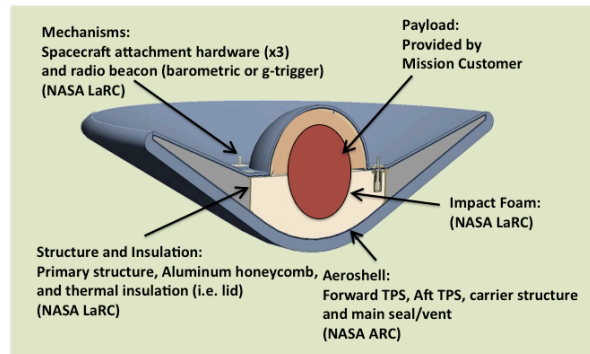
## Increasing reliability – reducing risk

The biggest challenge for any space vehicle, including the MMEEV, is to adequately prove the reliability of the components, subsystems, and the flight system as a whole. Many experts agree that a dedicated flight test is needed to achieve the one-in-a-million system reliability required, since the entry flight environment cannot be replicated in ground-based facilities. By leveraging common design elements, this approach could significantly reduce the risk and associated cost in development across all sample return missions, while also providing significant feed-forward risk reduction in the form of technology development, testing, and even flight experience, for an eventual MSR

implementation. The associated trade space analyses conducted as part of the MMEEV concept development also identifies technology areas that are currently inadequate to meet the needs of sample return missions. One such area already identified is a future replacement for the “heritage” version of Carbon Phenolic composites, the material of choice for sample return missions with significant reliability concerns, like MSR.

## MMEEV's potential

MMEEV is intended to have broad applications to any sample return mission, whether from the asteroid belt, the Moon, or Mars. The design trade tools and technology development within the project, particularly in the area of TPS and impact materials, have the potential to support many of the Agency's Exploration initiatives, including manned space flight.



Cross-section of generic MMEEV

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For more information about NASA's In-Space Propulsion program and aerocapture research, visit:

<http://spaceflightsystems.grc.nasa.gov/SSPO/ISPTProg/>